eeBuildings

Estimating Reduced Cooling Loads from Lighting Retrofits in Tropical Climates

About this Guide

This guide is designed to assist with estimating the reduction in the cooling load of a typical high-rise office building as a result of energy savings from lighting retrofits. A precise calculation requires multiple input values and extensive professional engineering work. This guide is intended to provide a simple rule-of-thumb that applies to typical high-rise office buildings in troical cities.

There are 2 ways that reducing lighting energy can result in reduced building cooling costs: 1) reducing the amount of work that the cooling system must do; and 2) reducing the capacity need to meet peak cooling loads, allowing for downsizing when chillers are replaced.

Less Work

Less electricity for lighting means less heat is produced by the lighting system, resulting in less work by the cooling system to maintain the same level of comfort.

$$\text{Total Annual Cooling Energy Saved (kWh)} = \frac{\text{Total Annual Lighting Energy Saved (kWh) x Fraction of Lighting Energy to Cooling}^{(1)}}{\text{System MCOP}^{(2)}}$$

For example, consider a lighting load reduction of 1 kW from fixtures operated 60 hours/week, 52 weeks/year, giving an annual lighting energy savings of 3,120 kWh:

Total Annual Lighting Energy Saved (kWh)		Fraction of Lighting Energy to Cooling(1)		System MCOP(2)		Total Annual Cooling Energy Saved (kWh)
3,120	×	0.87	÷	4	=	679

Downsizing

The decrease in heat produced in a building at any given time means that a smaller chiller configuration can achieve the same cooling. Thus, when chillers are replaced, less capacity would be required. The estimated downsizing potential is expressed in the following formula.

Potential Downsizing for Chiller = Lighting kW reduced x Conversion from kW to Tons x Equipment Use Factor

For example, consider a peak load reduction of 1 kW:

Lighting kW Reduced		Conversion from kW to Tons		Equipment Use Factor(3)		Potential Downsizing for Chiller (Tons)
1	×	0.28	×	0.75	=	0.21

Source:

"Calculating Lighting and HVAC Interactions," R.A. Rundquist et al., *ASHRAE Journal*, November 1993. – Reprints provided by the EPRI Lighting Information Office through US EPA.

Notes:

(1) The fraction of lighting energy to cooling reflects the percentage of heat that must be removed by mechanical cooling. For example, cooler nights means more heat can dissipate naturally at the end of the day. The coefficient, 0.87, for Miami, Florida, as an example of a city with year-around cooling.

(2) The Marginal Coefficient of Performance (MCOP) is an estimate of the cooling system's efficiency and the degree to which the system can benefit from the reduced load. Lower MCOP means more benefit. To be conservative, the value of 4 was chosen as representative of typical existing buildings. Newer buildings would have a lower MCOP.

(3) Like MCOP, the Equipment Use Factor discounts the system's ability to fully benefit from the load reduction. A conservative 0.75 was chosen as representative of typical existing buildings. New buildings would have a higher Equipment Use Factor.

Contact: Gary McNeil, US EPA, mcneil.gary@epa.gov
Steve Bagley, ICF, sbagley@icfconsulting.com